Companion Modelling for Resilient Soil & Water Management in NorthernThailand:

Gaming & Simulation to Integrate Stakeholders' Perceptions for Collective Learning & Action

Mae Salaep catchment in Chiang Rai province

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CGIAR Challenge Program on WATER & FOOD

The water productivity challenge: Growing more food with less water

ComMod

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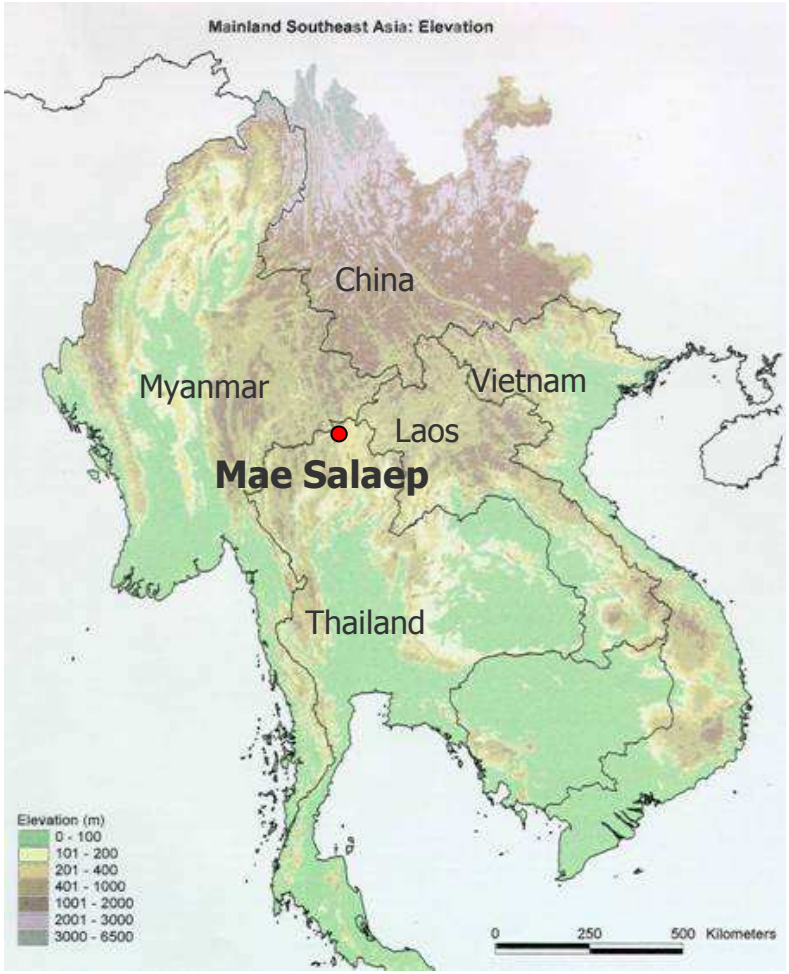
- 2nd cycle on plantations & rural credit: economic tipping points
- 3rd cycle on collective water management: adaptive capacity & uncertainty management
- Lessons learned, multiple effects & impact

Mae Salaep Akha village & soil erosion risk / crop diversification in montane SE Asia

- Land-use change & uncertainty
  - Until early 1980s : shifting cultivation mainly for subsistence
  - 1980s-2000s : semi-permanent cultivation, cash crops & **projects**
- The problem: increased risk of land & water degradation perceived by Thai lowlanders & **decentralization**

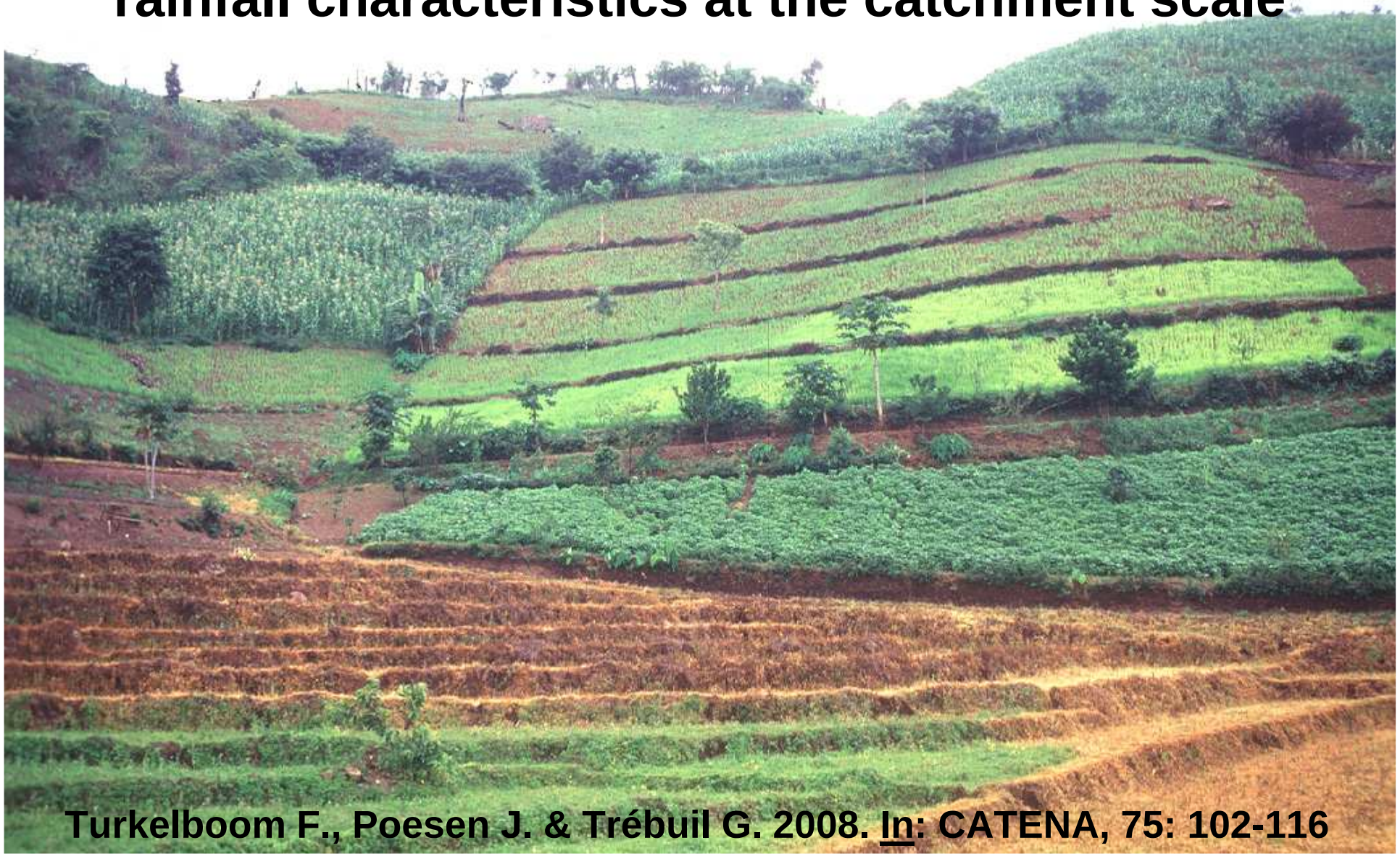


But soil erosion x crop diversification relationship in farmers' fields still not documented / understood !

Research objectives

- To create a collective learning & action process on this complex issue of risk of land & water degradation
- To stimulate information sharing & dialogue among all concerned stakeholders (different farming households, various local institutions, researchers)
- To facilitate the bottom-up emergence & negotiation of ecologically adapted & socially acceptable collective action for improved soil & water conservation at catchment scale

On-farm agronomic survey on crop diversification X soil erosion risk across slope (angle, length) & rainfall characteristics at the catchment scale



Turkelboom F., Poesen J. & Trébuil G. 2008. In: CATENA, 75: 102-116

Knowledge synthesis from field surveys:
Definition of erosion risk domains & tipping points

Integration of slope, cover thresholds & fallow effect (little erosion in new fields after clearing) ➔ Identification of field conditions corresponding to low, moderate & high soil erosion risk / Farm type (A, B, C)

Soil critical cover	Field history	Slope characteristics					
		< 47%		47-57%		>57%	
		<25m	>25m	<25m	>25m	<25m	>25m
< critical cover	Fallow clearing	18*		7	7	25	25
	Old field	43	27	14	58	33	51

*Percentage of field observations in the given situation displaying worsening erosion symptoms compared to the previous field visit.

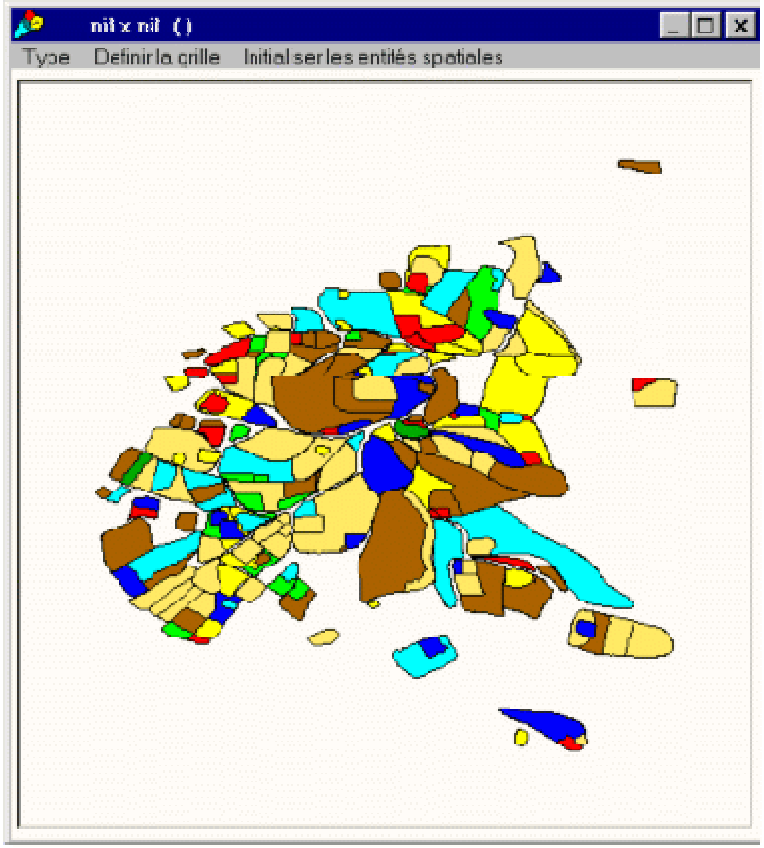
Socio-economic differentiation & vulnerability: 3 main types of Akha farming households

- A: small farms, often newcomers or young families, mainly on steep land,
  main orientation: annual cash crops

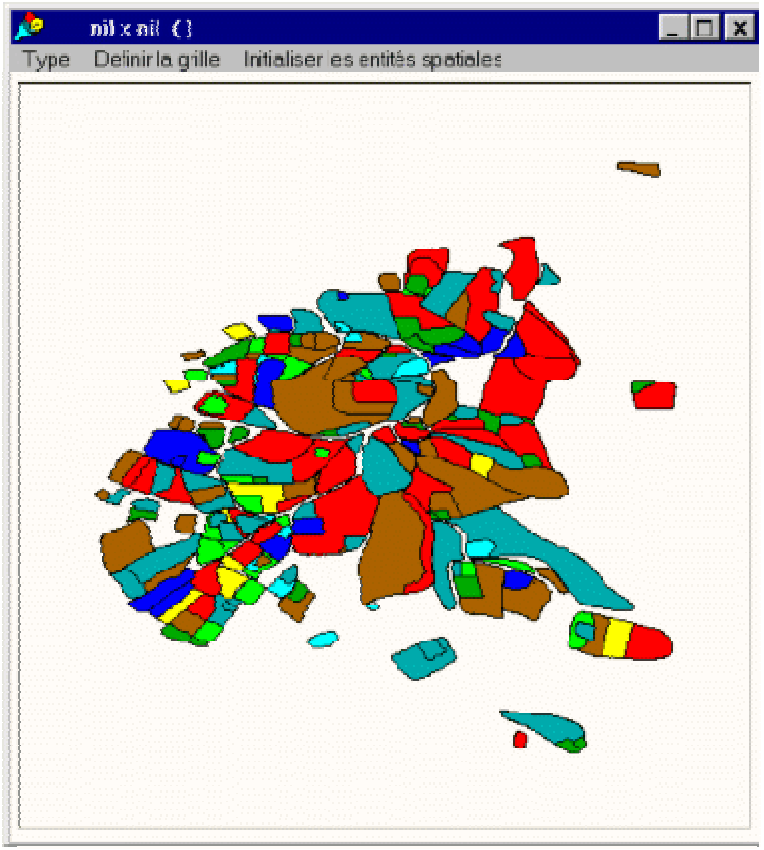
- B: medium-sized farms, conservative behaviour, mainly subsistence crops
  & low input cash crops
- C: largest holdings, often early settlers with access to best land (terraced paddies),
  market oriented, diverse combinations
  of on & off-farm productions & activities

1st MAS-GIS model on soil erosion risk: Simulation results

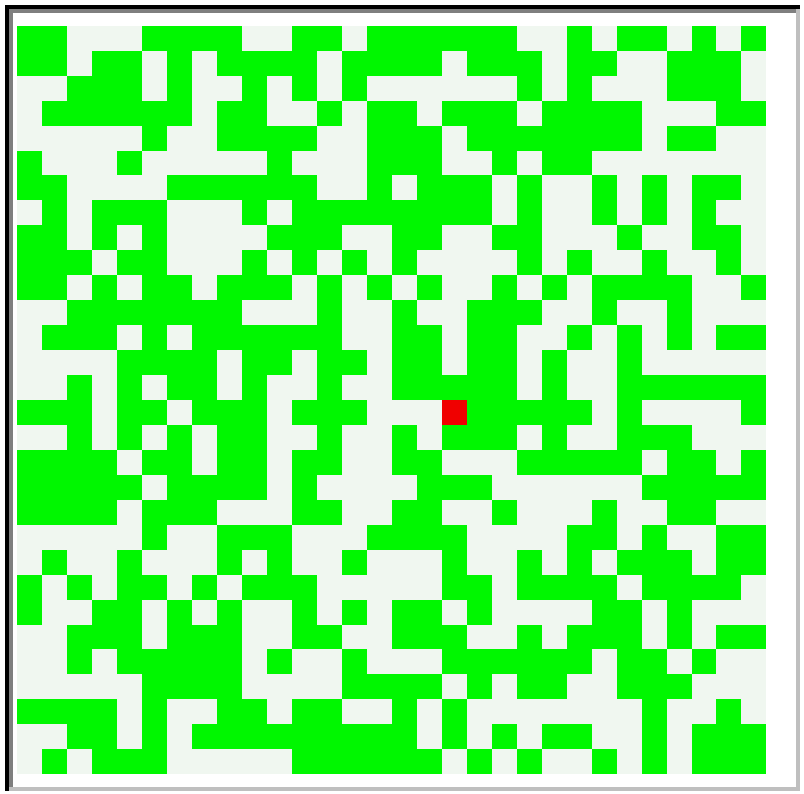
Crops and cropping patterns



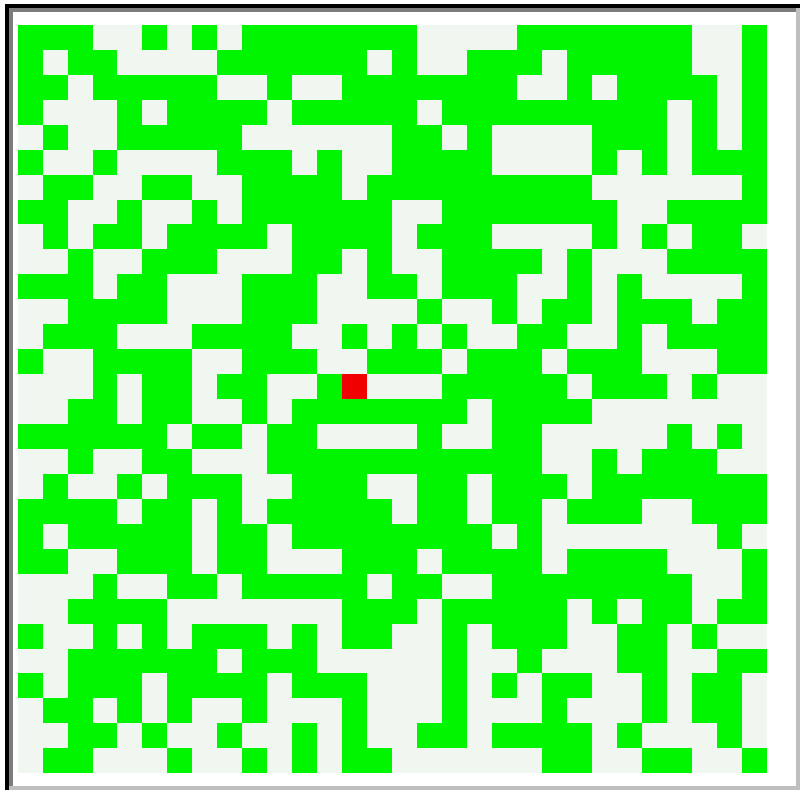
Erosion index



Cellular automata, percolation thresholds & diffusion processes (cormas.cirad.fr)



P= 0.53

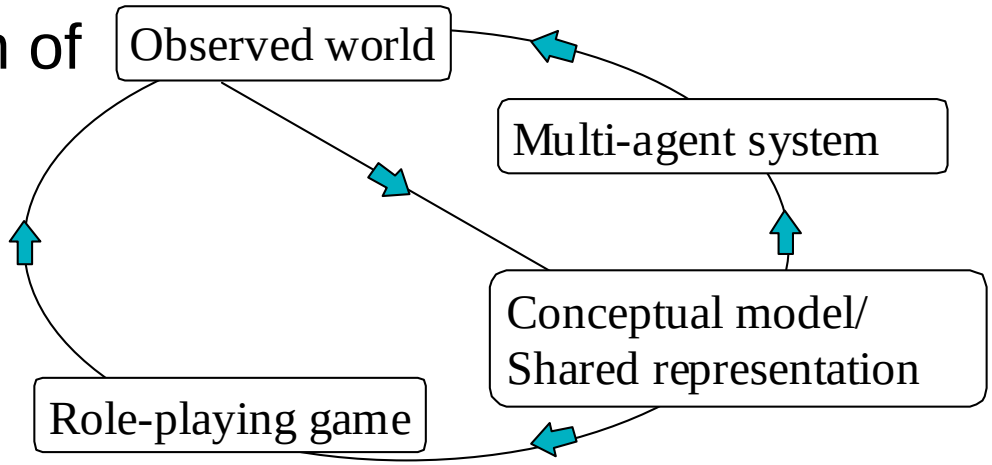


P= 0.58

The probability to observe a limited fire is high if *p* lower than 0.55, whereas an extensive fire is likely to occur if *p* is greater than 0.55

Agent-Based Modelling with stakeholders

- Convenient **to integrate knowledge** from different sources at **multiple scales**, **quantitative & qualitative** data, etc.
- Choice of **an evolving** Companion Modelling (ComMod) **process** (Bousquet, 1999) http://www.commod.org
- The **ComMod** approach:
  - An iterative & continuous process alternating field & laboratory activities / Test of hypotheses
  - Collective construction of a shared understanding & representation of the problem…
  - To facilitate communication & support the negotiation of a concrete action plan through collective exploration of scenarios

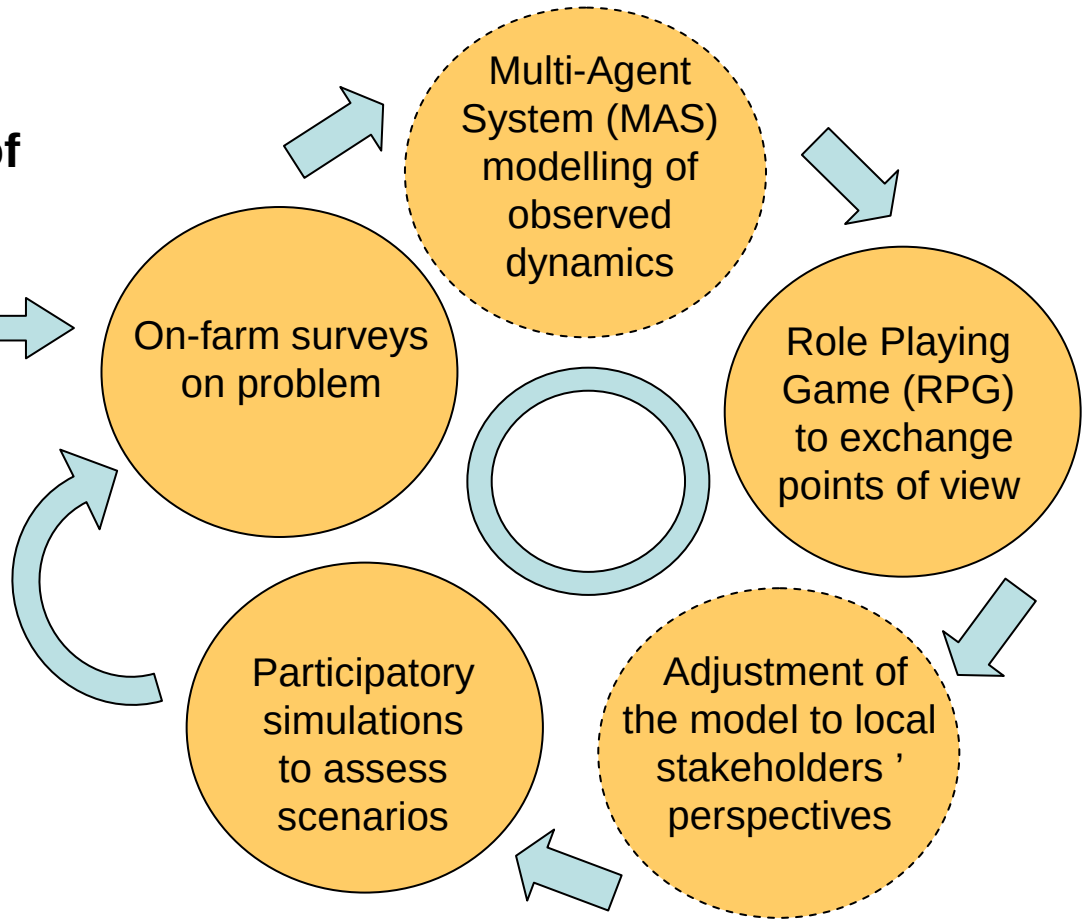


Companion Modelling (ComMod) process: iterative & adjusted to stakeholders' requests

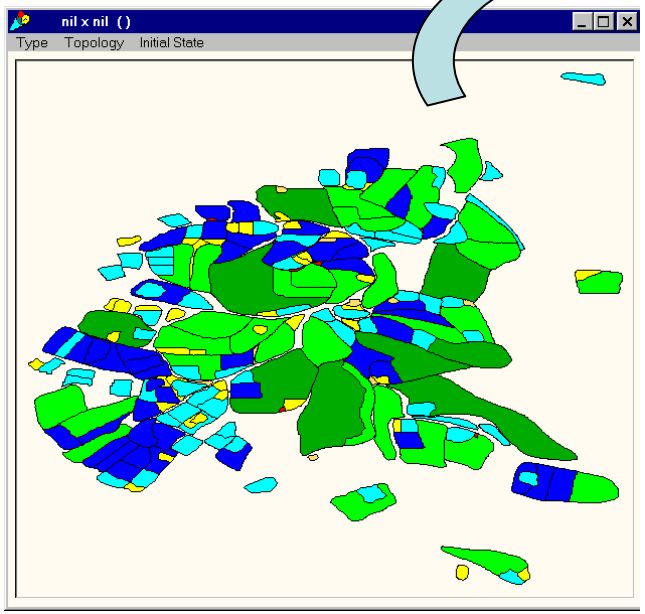
1st ComMod cycle initiated by researchers on risk of land degradation

2nd ComMod cycle on a new issue as requested by villagers: rural credit & plantation crops

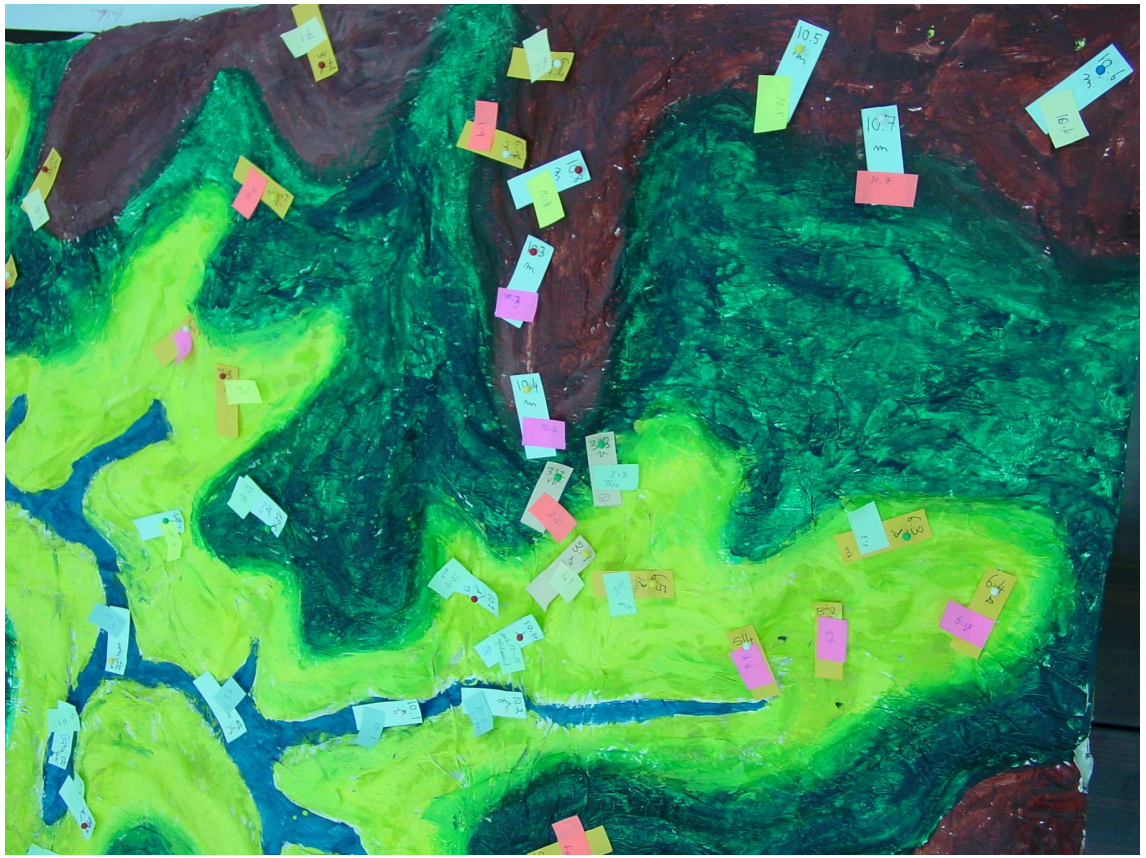
3rd ComMod cycle focusing on another new question: collective water use to irrigate orchards & gardens



1st Role playing game: a 3D block model, similar to MAS model interface & collectively managed



4 classes of slopes are displayed with different associated soil erosion risk

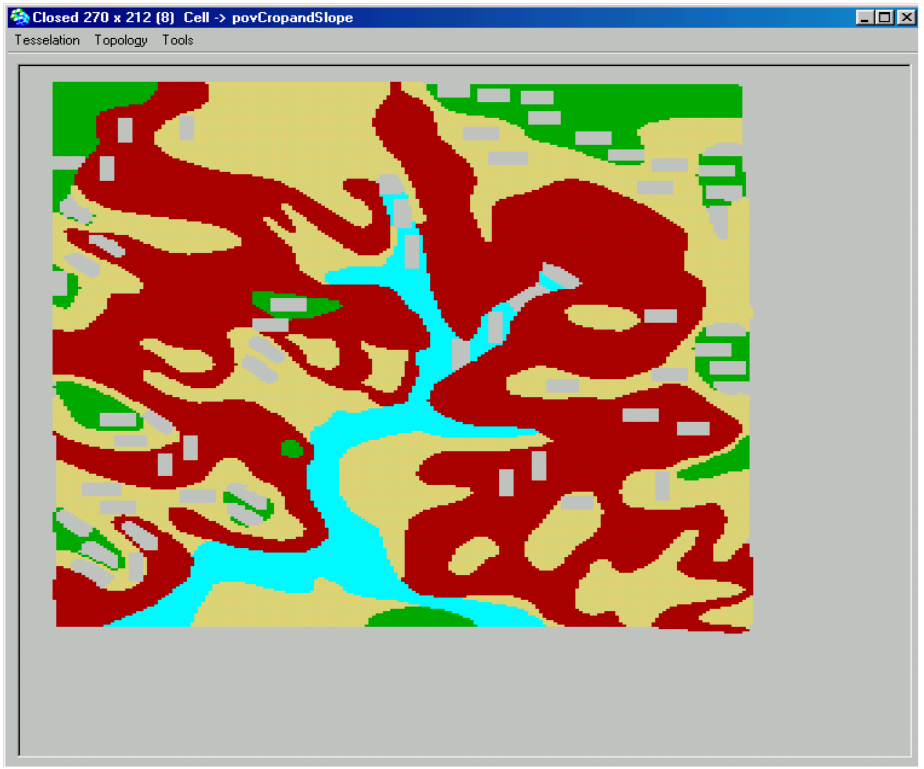


- Farmers fields are located on more (A) or less (C) steep slopes

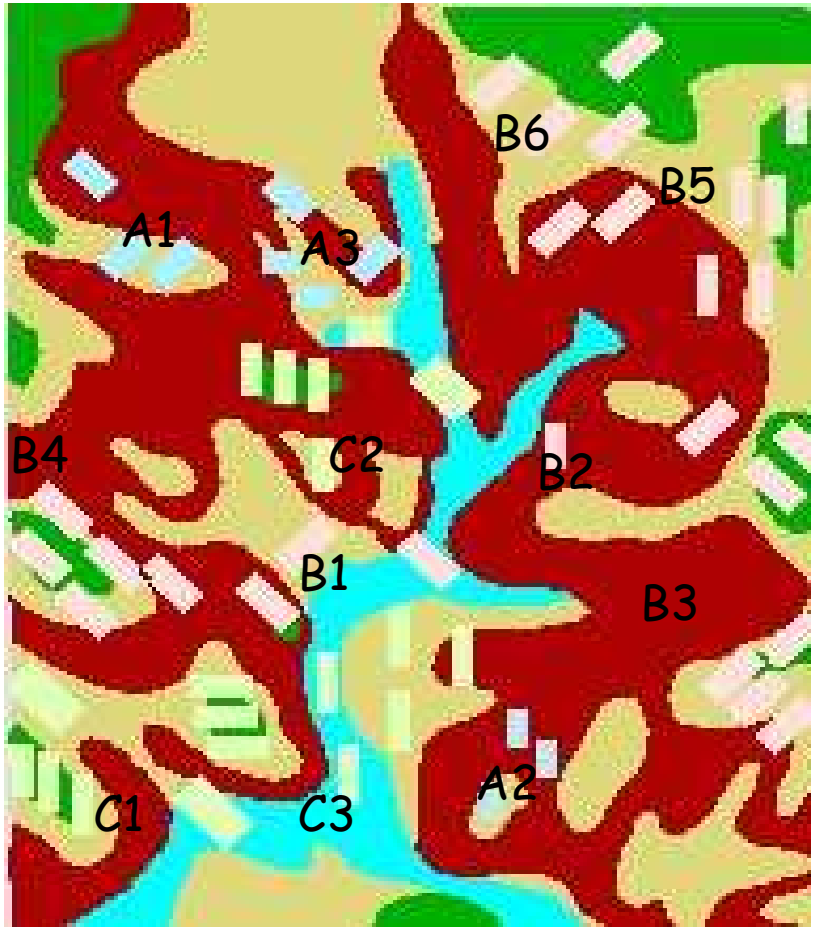
- Crops are allocated to fields by farmers

From the 1st RPG to a 2nd & simpler ABM

- The new ABM plays the RPG sessions: same interface, main agents, rules, etc.
- 2 kinds of MAS simulations could be run with stakeholders to assess land use scenarios & economic change :
  - Based on the 1st RPG (preferred by farmers)
  - Based on the initial & more complex MAS-GIS researcher model



Spatial interface of the 2nd Agent Based Model used with Akha farmers



Slope

- Flat
- Moderate
- Steep
- Very steep

Farms

- Type A: Small market integrated farms
- Type B: Medium-sized & conservative farms
- Type C: Large farms & diverse productions

From the first to the second ComMod cycle

Cropping system

Slope

Rainfall

Risk of land degradation

Access to credit

Adoption of perennial crops

Off-farm activities

Price fluctuations

→ To explore the expansion of perennial crops, farmers created a shift of focus from agro-ecological to socio-economic dynamics

→ Importance of a flexible modelling approach & tools

Back to the field: Survey on roles of the two main plantation cash crops on farm types

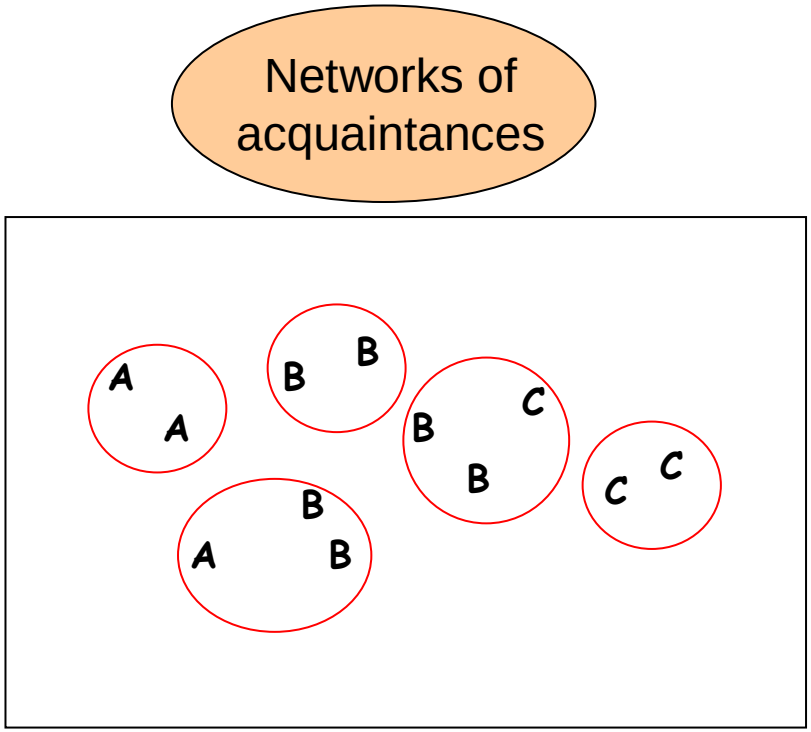
Lychee (3-70 Bahts/kg) →

For secured investors (type C)

Green tea (6-12 Bahts/kg) →

« Poor man perennial crop »

Field survey to understand the formal & « informal » village credit systems



- Type A: Small market integrated farms
- Type B: Medium-sized & conservative farms
- Type C: Large market integrated farms, diverse productions

2nd Role-Playing Game & simulations

3-day village workshop:

- Day 1: gaming sessions
  - *Morning* : rules suggested by researchers
  - *Afternoon*: based on rule modified by the players
- Day 2: individual interviews
  - To better understand the players' behaviour & relations with reality
  - To socially validate the model with users
- Day 3: plenary session of simulations of proposed scenarios & debate
  - To explore & assess scenarios indentified by the players, and
  - To design a collective action plan

4-5 rounds of play (= crop years) simulated in each Gaming session

1. At the gaming board
Choice of crops
Allocation to fields

2. At the market desk
Draw off-farm cards
Clear accounts

At any time:
free negotiation among players

3. At the credit desk
Request loans
Reimburse loans

Main steps in a round of play of the 2nd role playing game

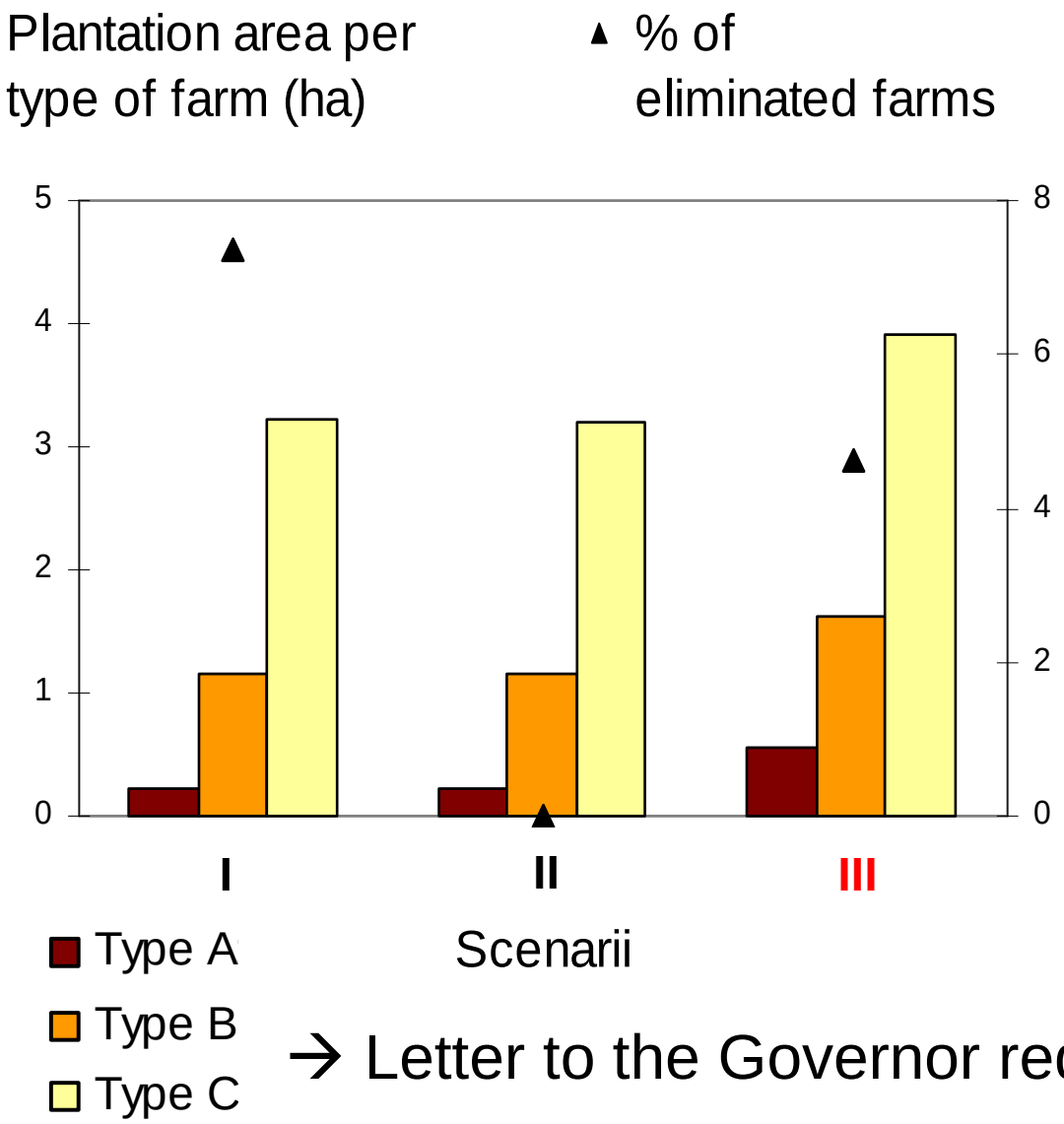
3rd simple ABM created from this 2nd game

Selected scenarios for simulations: loan duration & access to formal credit as social & economic tipping points

Scenario	1	2	3	4	5	6
Duration of formal loans (1 or 3 years)	1	1	1	3	3	3
Distribution of formal system loans (Access or No Access for small landholders)	NA	NA	A	NA	A	A
Informal credit: Configuration of networks of acquaintances (Small or Broader)	S	B	S	S	S	B

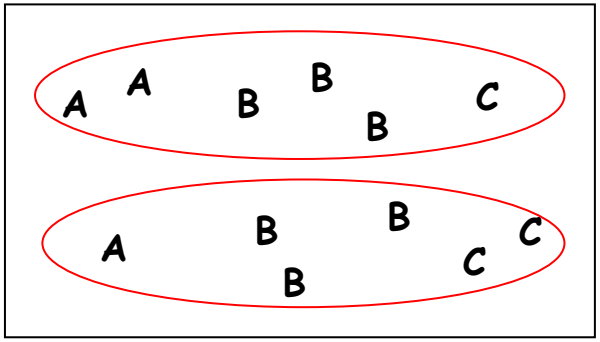
Barnaud C, Bousquet F, Trébuil G. 2008. In: Ecological Economics, 66(4): 615-627

Simulation results on effects of rules for formal & informal credit on land cover & farm survival



Scenario I: current situation and existing credit rules

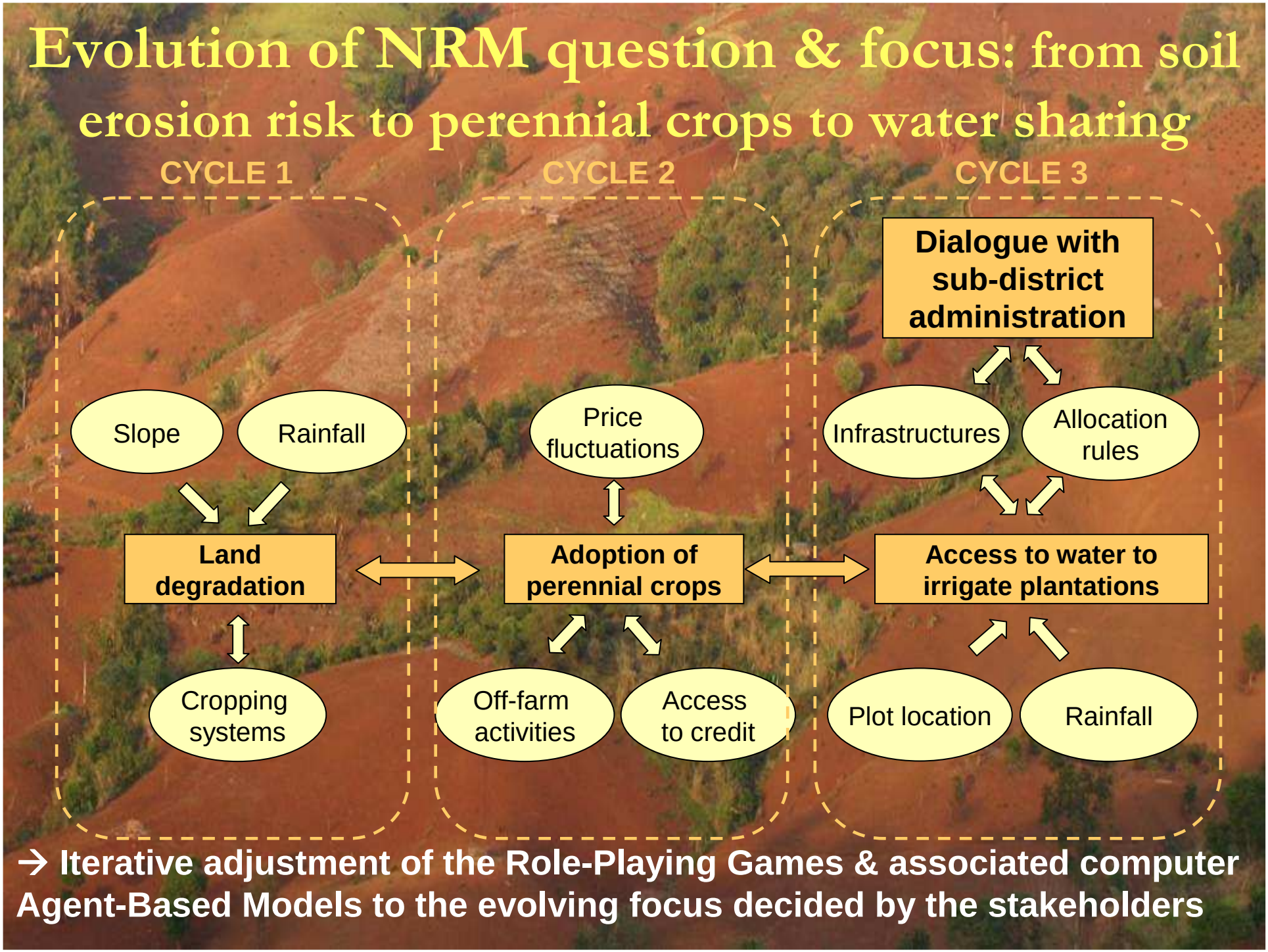
Scenario II: modified rules for informal credit (larger & mixed networks of villagers)



Scenario III: modified rules for formal credit (longer period for reimbursement & more equitable distribution)

→ Letter to the Governor requesting longer term loans

Evolution of NRM question & focus: from soil erosion risk to perennial crops to water sharing



→ Iterative adjustment of the Role-Playing Games & associated computer Agent-Based Models to the evolving focus decided by the stakeholders

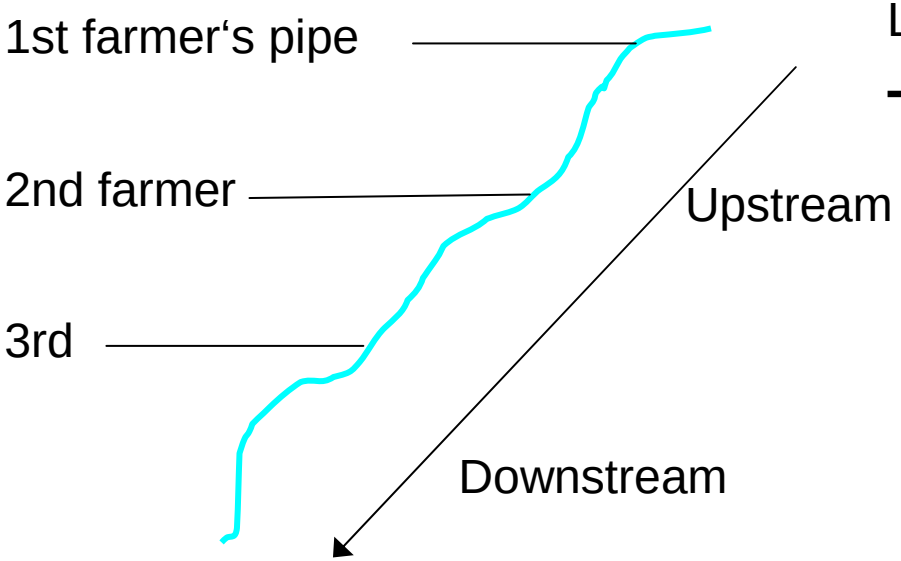
3rd Cycle: irrigation water sharing in plantations, up-scaling & power relations

- Expansion of irrigated perennial crops to increase & stabilize quality, yields & farm incomes

- Shortage of water in uplands / increasing user needs

Lychee

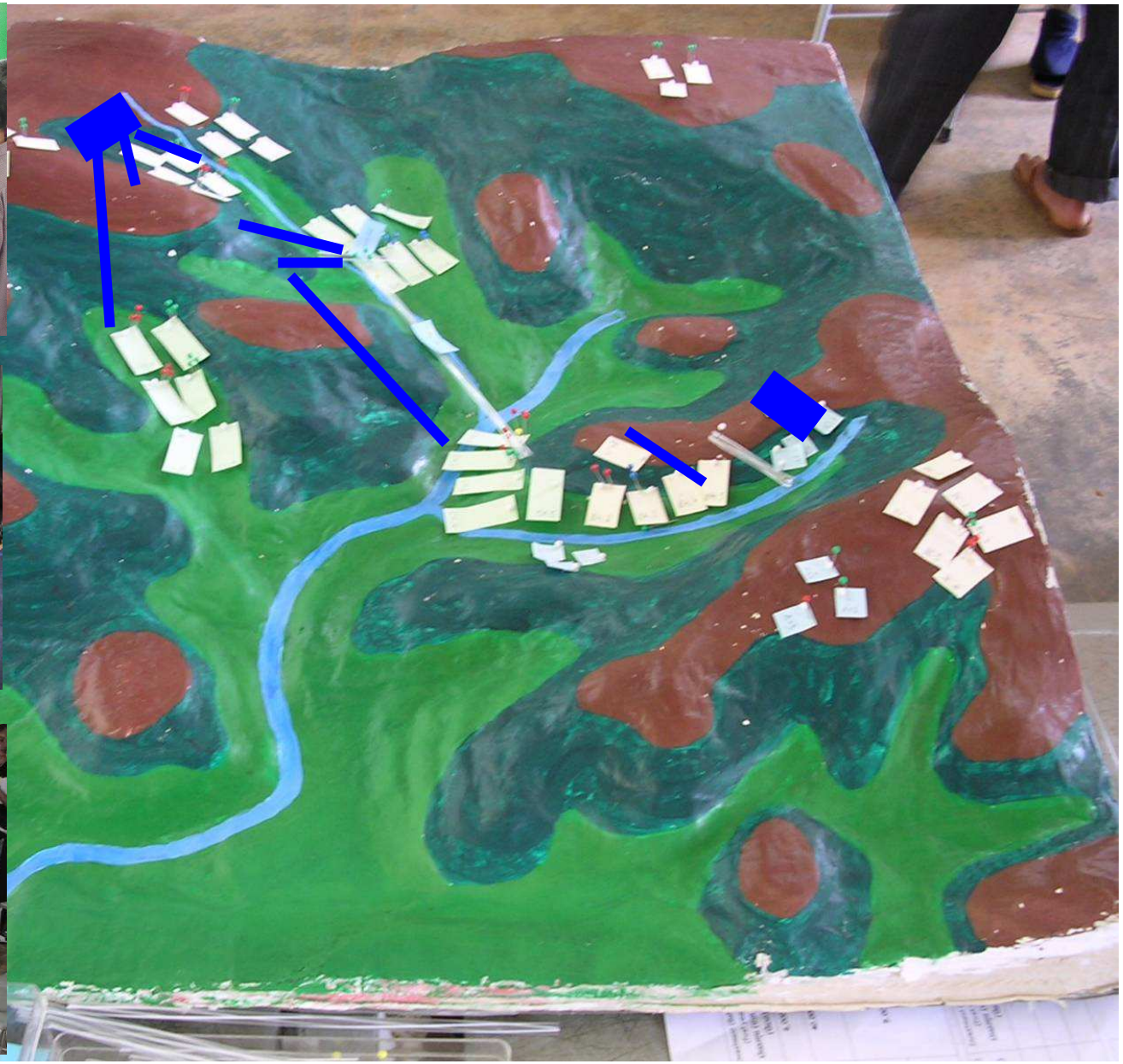
Oolong tea



→ Unequal access to water

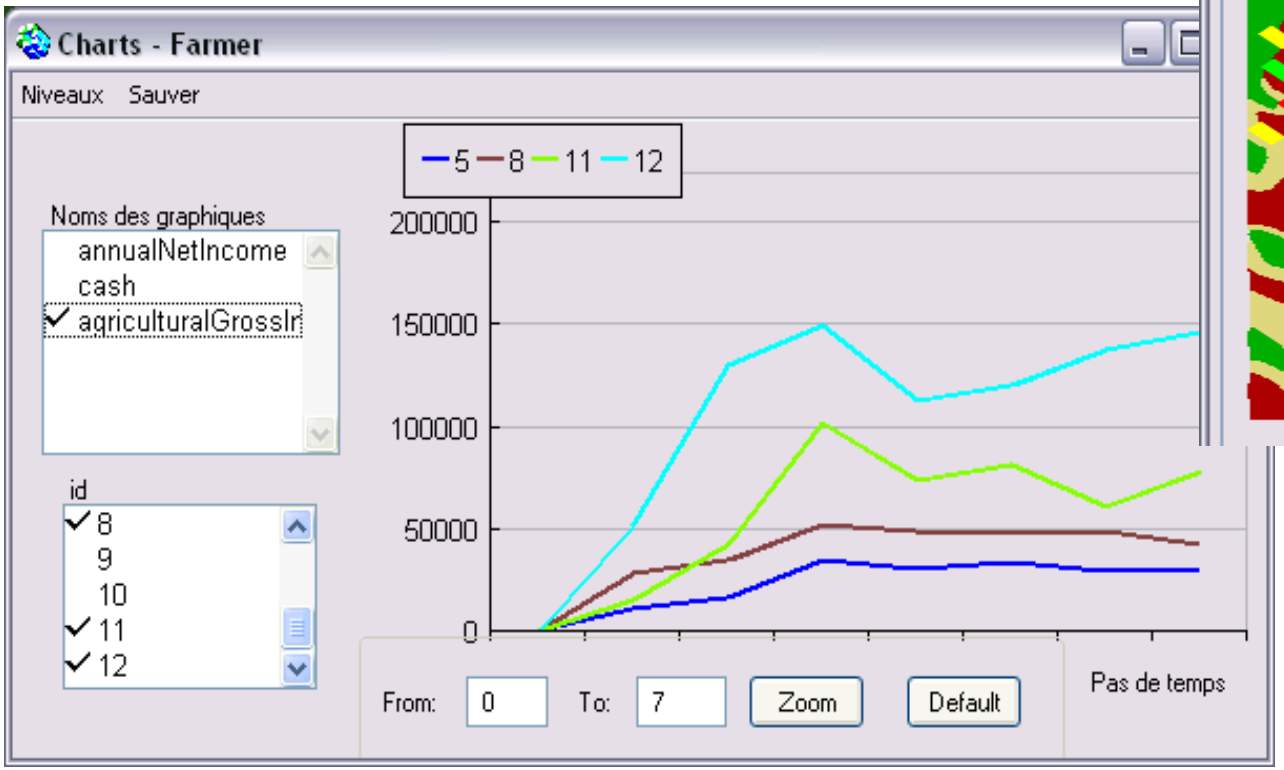
- « First arrived first served »
- A majority of families have no access to irrigation
- Current rules are sustained by well-off families (Type C)

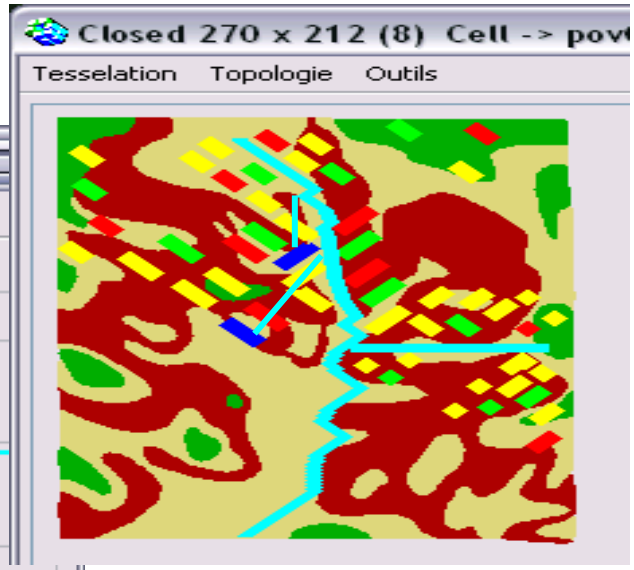
3rd RPG sessions discussion



3rd Water Management ABM: simulation results for collective analysis & negotiation support

Who benefit from a given set of rules?



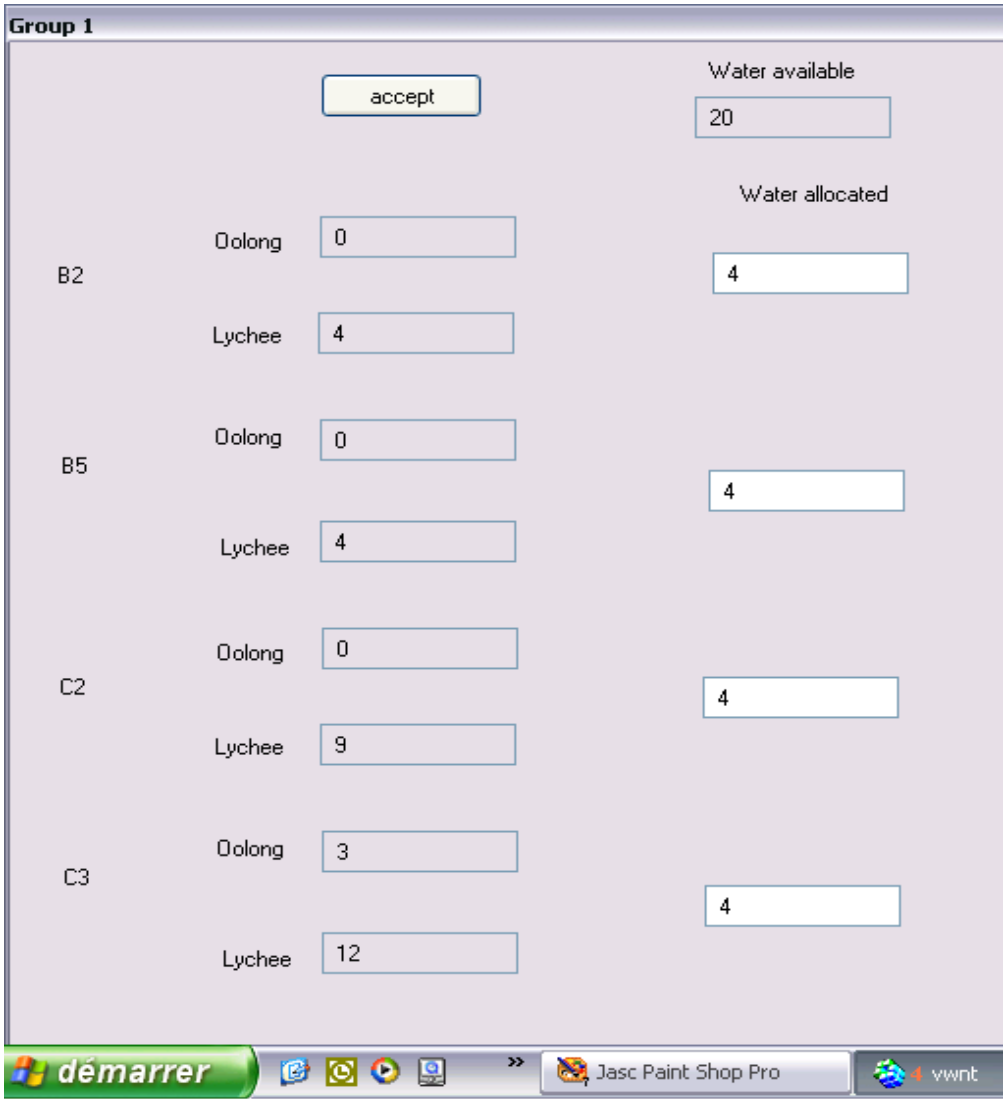


Spatial interface

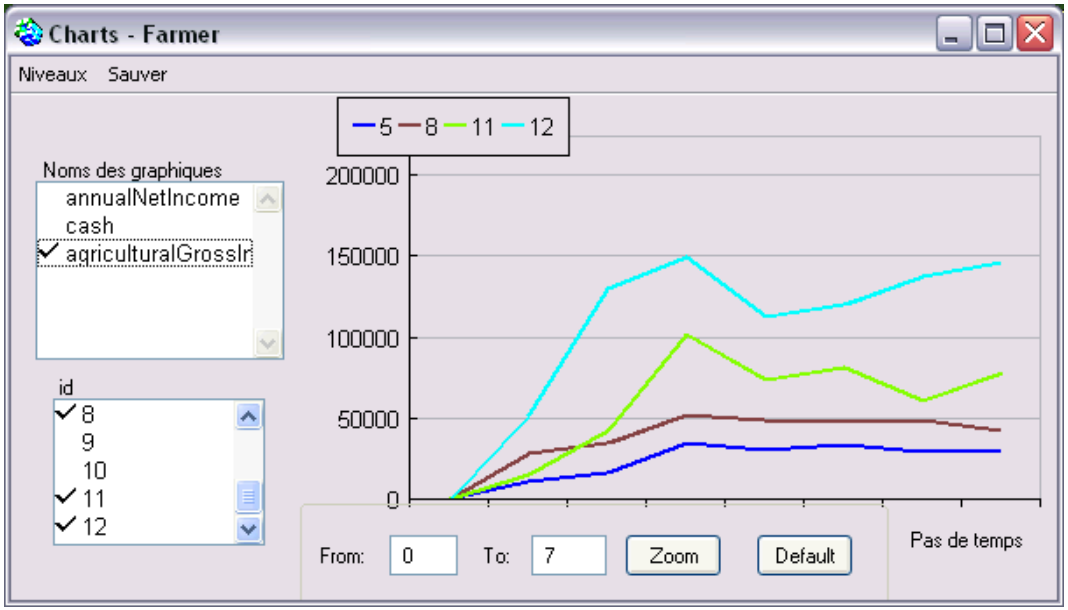
→Villagers discuss type of water storage, distribution structures & rules for the allocation of scarce irrigation water in the dry season

→ A project under negotiation among villagers to request funding

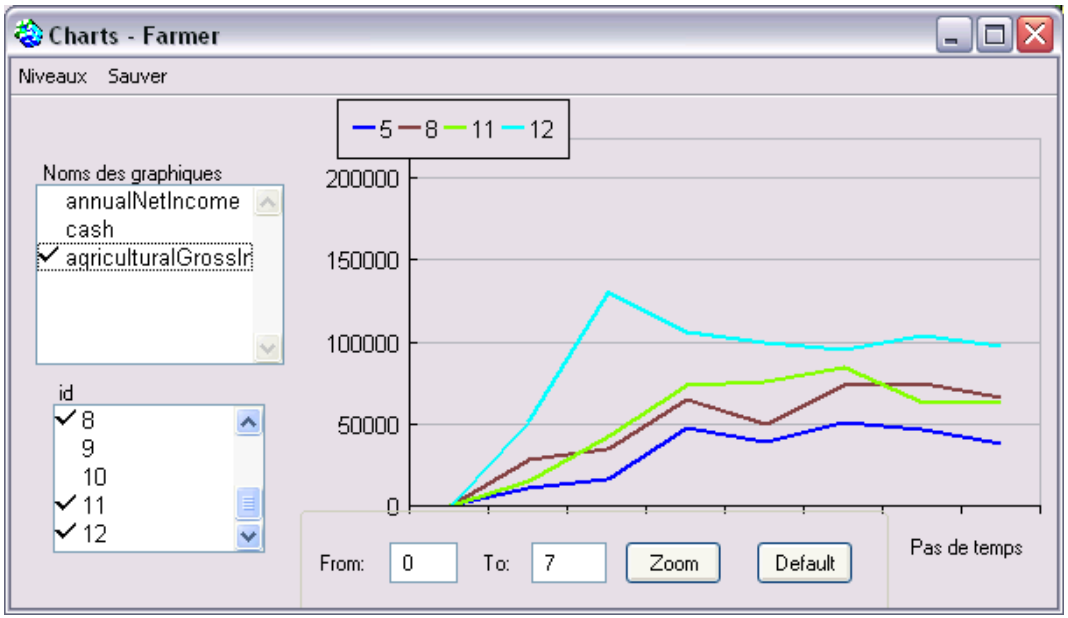
Participatory simulations in homogeneous groups: effects of different rules for water allocation under the small weirs scenario



Simulating the evolution of gross farm income of 4 farms

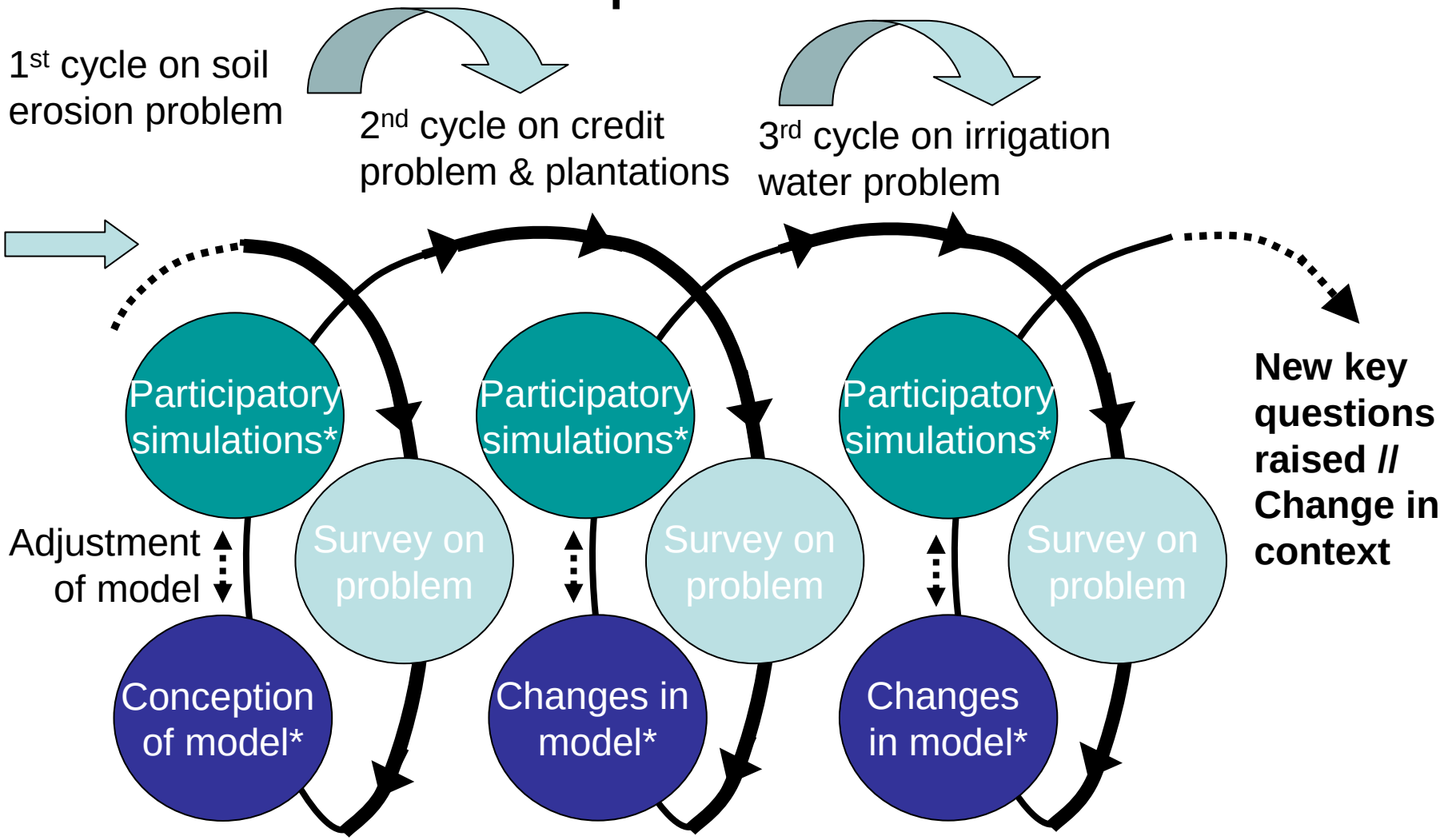


Scenario 1 : the quantity of water allocated is proportional to the area to be irrigated at the farm level



Scenario 2 : the quantity of water allocated is identical across farm types

Overview of ComMod process in Mae Salaep catchment



* 1 conceptual model, 2 implementations: Role-Playing Game & Multi-Agent System

Collective learning & action stimulated by games & ABM simulations

- Interactive exchange & production of knowledge & perceptions
- Better communication & understanding of other stakeholders
- Endogeneous identification & negotiation of acceptable solutions
- Importance of the modelling process: flexibility, openess
- Focus on farmers' evolving interest to sustain the process
- Management of power relationships – equity is essential
- Contribution of hybrid simulators for out & up-scaling the process

For more information:

http://www.cpwf25.sc.chula.ac.th (This project)
http://www.commod.org (General)
http://www.ecole-commod.sc.chula.ac.th (E-learning)

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CGIAR Challenge Program on WATER & FOOD
The water productivity challenge: Growing more food with less water

ComMod